ISS Study2A Simulation

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Outline

- Performance as a function of proton bunch length σ_z
- Target Survey
- Performance with magnet and rf errors

Performance as a function of proton σ_z

Figure of merit: Number of muons within the acceptances, transverse $A_T = 30$ mm rad and longitudinal $A_L = 150$ mm per incident proton on target.

We have examined the dependence, with the proton bunch length, of the figure of merit for the U.S. design.

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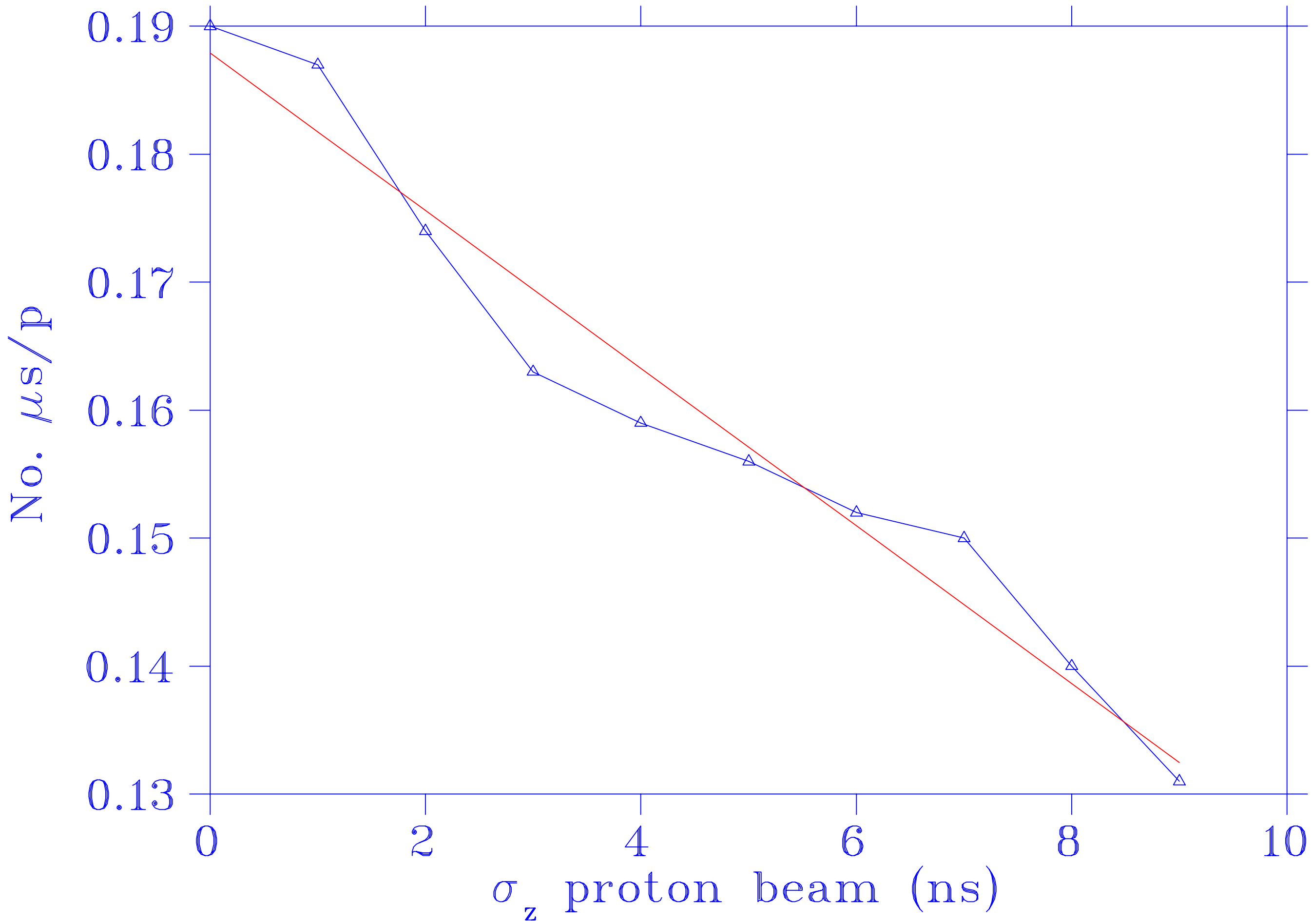
Performance as a function of proton σ_z



The red line is a linear fit to the data

Performance as a function of proton σ_z

As the proton length increases more muons fail to meet the conditions of optimal tuning of the channel. This is *surprising*; in a previous study (MUCOOL-note 031) we concluded that *...the most important constrain to the proton bunch length is the intrinsic width of the muon beam due to the kinematics of the pion decay. A proton bunch length as large as ≈ 2 ns will not significantly increase the muon phase space volume*

$\Delta_{tg} \approx 0.15$ ns $\qquad \Delta_{\pi decay} \approx 2.6$ ns

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Performance as a function of proton σ_z

σ_z %	μ_A/π	μ_A/p
1 fs	0.132	0.19
1 ns	0.129	0.187
2 ns	0.122	0.174
3 ns	0.117	0.167
4 ns	0.113	0.159
5 ns	0.109	0.152
7 ns	0.102	0.146
9 ns	0.093	0.133

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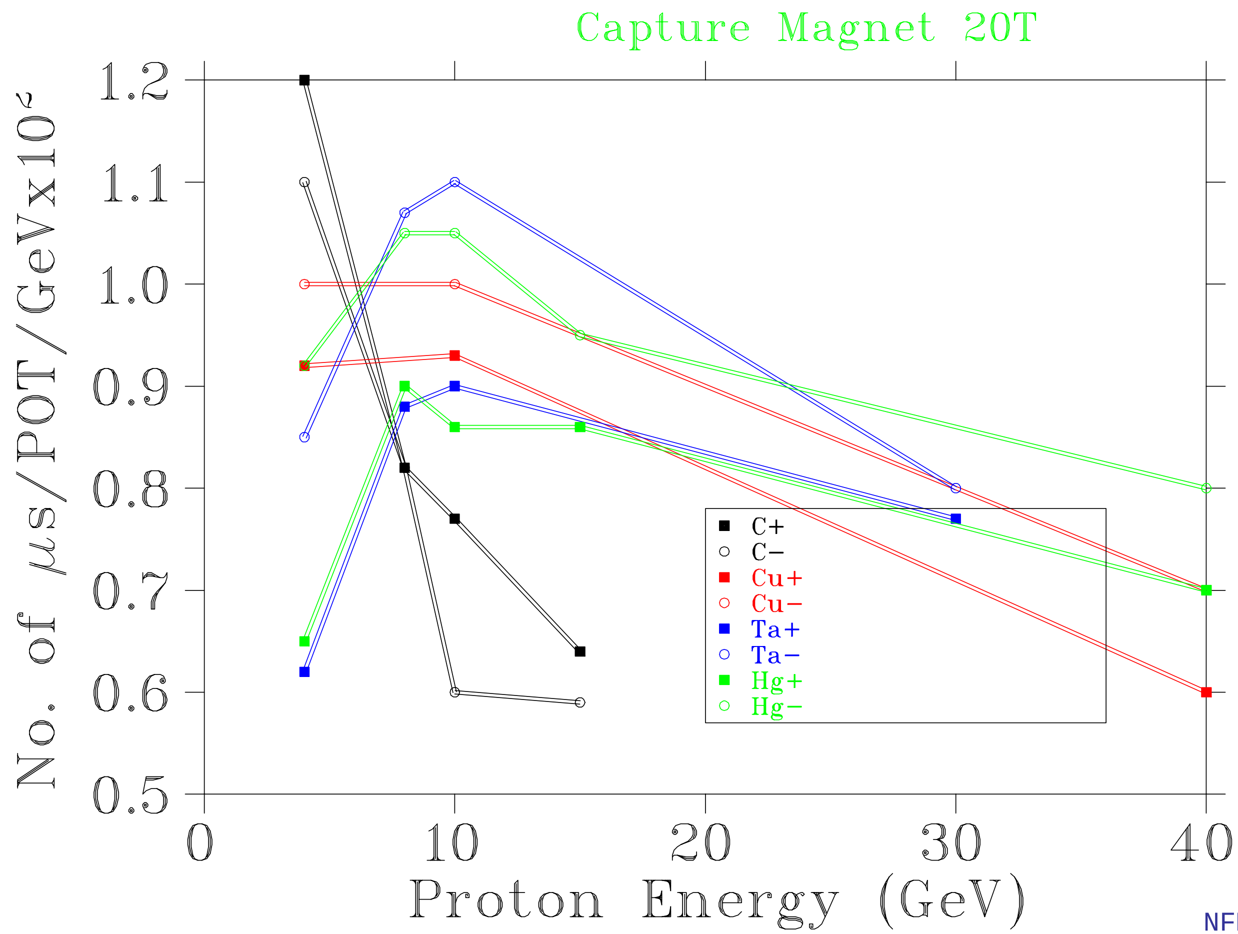
Target Survey

MARS15 production files   Capture magnet

$\mathrm{B}_z = 20\ T$ (S. Brooks)



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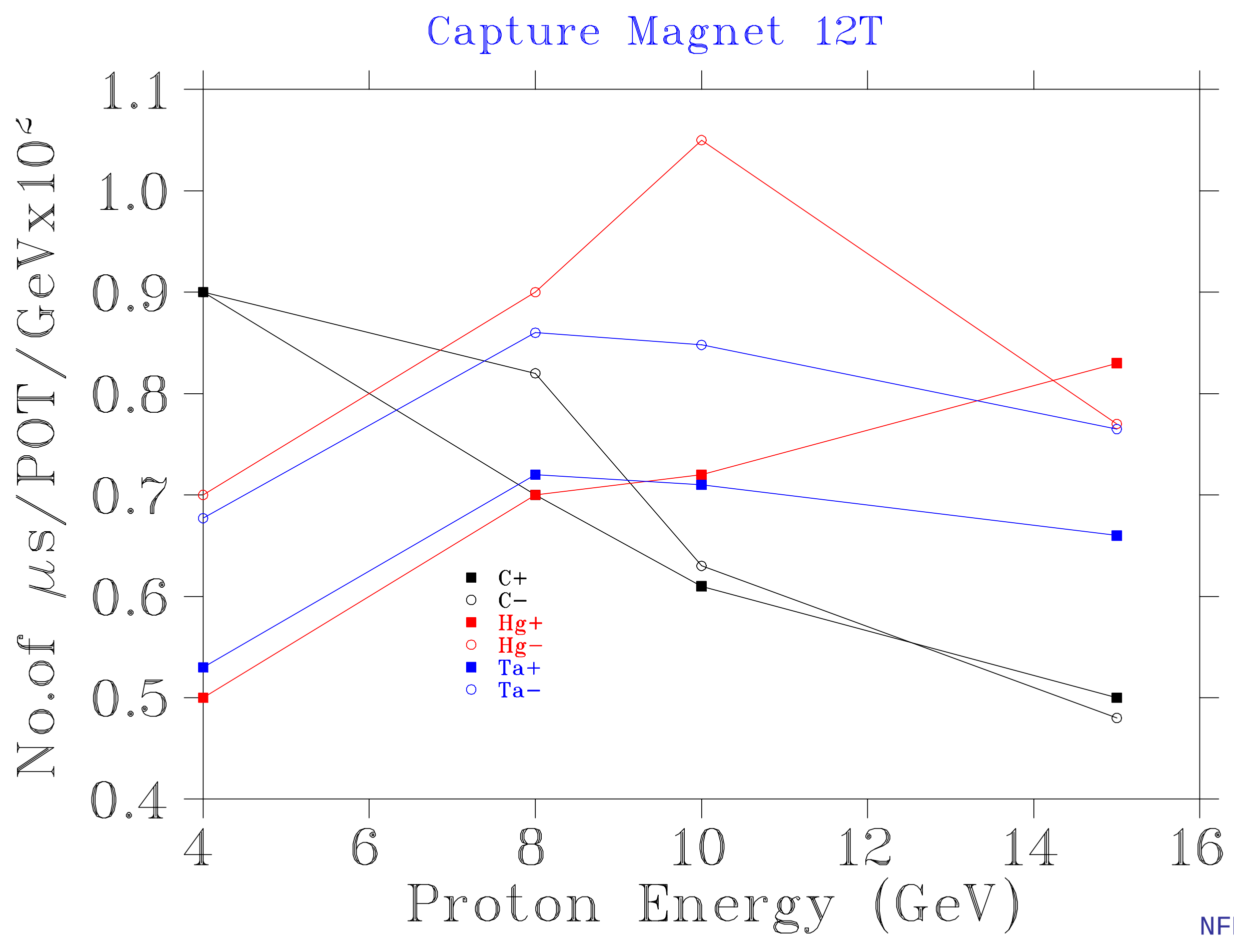
Target Survey

MARS15 production files Capture magnet $B_z = 12\ T$ (S. Brooks)



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Target Survey

Energy (GeV)	Target	L (cm)	μ_A/p/GeV μ^+	μ^-
4	C	66	0.012	0.011
10	C	66	0.0077	0.006
10	Cu	27	0.009	0.010
10	Ta	20	0.009	0.011
10	Hg	25	0.0086	0.0105

Performance with magnet and rf errors

First attempt to evaluate the dependence of the U.S. front-end performance to random magnet power supply errors as well as rf.

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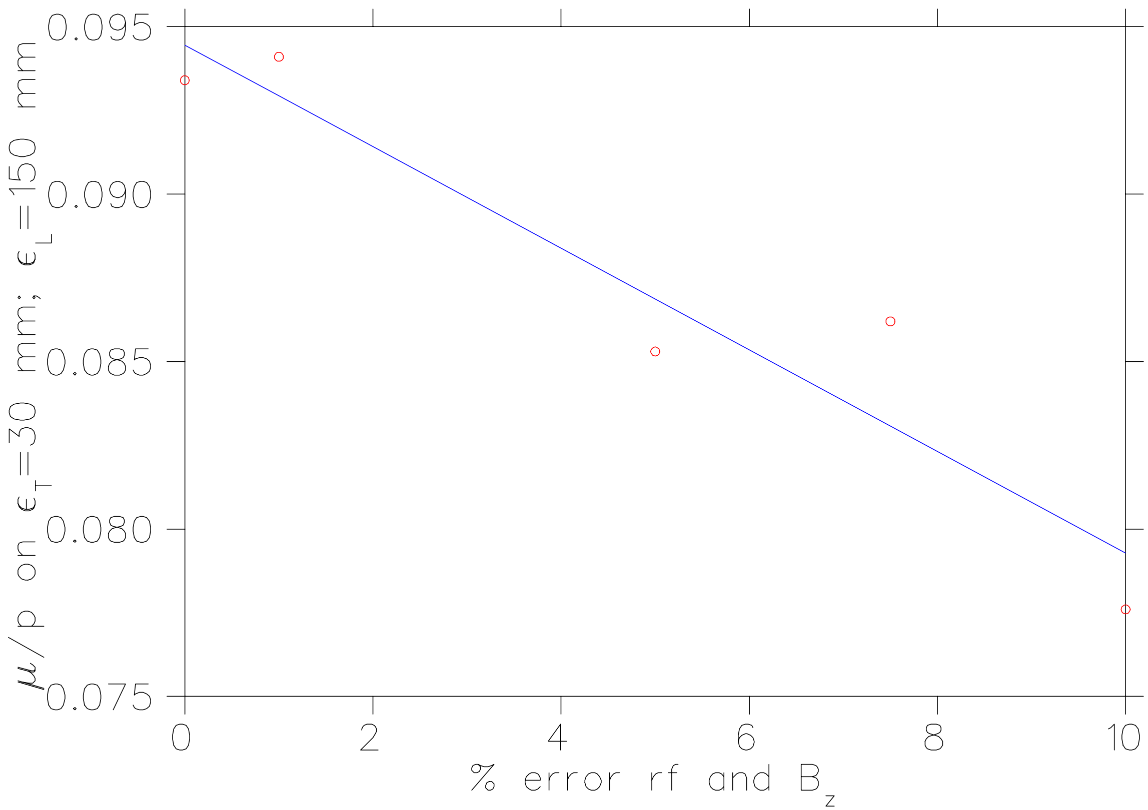
Magnet power supply and rf errors

The magnet lattice was broken into 10 sections. The magnets in each section were given the same error. All rf cavities were shifted by the same amount from their nominal values.



Magnets: random errors

The magnet lattice was broken into 0.75 m sections. The magnets in each section were given random displacement and misalignment.

Magnets: random errors

σ %	μ_A/π	μ_A/p
0	0.098	0.093
0.1	0.094	0.089
0.2	0.092	0.088
0.4	0.092	0.088
0.6	0.089	0.084
1	0.071	0.067
2	0.034	0.033
3	0.015	0.015

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Performance with reduced gradient

Changing the gradient of rf cavity from 15.25 to 10.25 MV/m, the performance is reduced by $\approx 20\%$.

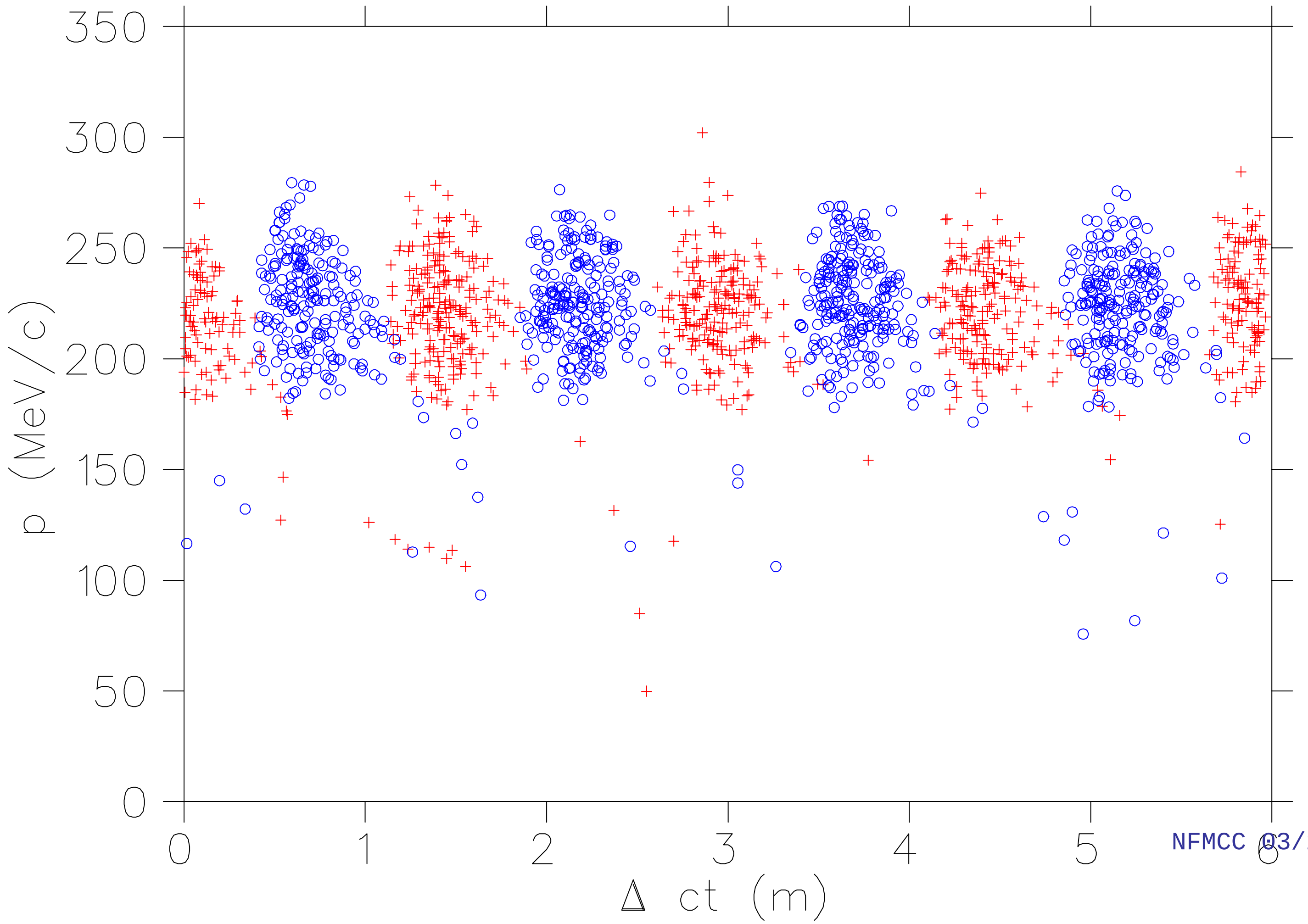
It is expected that rf cavities will be produced with a range of E_{MAX}. Question: is it possible to located the best cavity in particular part of the channel and maintain the performance? In this study, 15.25 MV/m cavity were used in the front of the cooling section and the rest were 12.25 MV/m cavities.

Performance with reduced gradient

High E	Low E	μ_A/π	μ_A/p
64	65	0.094	0.089
32	97	0.092	0.087
16	113	0.093	0.088
12	117	0.096	0.09
8	121	0.08	0.076

both signs

The front end prepare both sign muons simultaneously for acceleration.



Summary and Conclusions

- 1 ns proton beam increases the performance by 11% respect to 3 ns.
- C is best for $E_p \approx 5$ GeV; Ta is best (20 T) for 10 GeV
- $20 \Longrightarrow 12\ T$: C drops 25% ; Ta drops 22%
- preliminary errors studies; much more to be done

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